The Traceability and Reporting Program: Mariner Mars 1971—Integration, Review, Evolution

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The Traceability and Reporting Program (TARP) is the basic support software utilized by the DSN Operational Data Center (ODC). It is used during mission operations to provide administrative control and selective dissemination of information concerning transferable DSN mission data products. Significant qualitative information relative to data record production, quality, logistics, and recycleability status are entered into the data base with respective operational data. Data records covered in TARP consist of original, system, and master magnetic tapes with supplemental microfilmed hard-copy records. The execution of this program within ODC in support of Mariner Mars 1971 (MM'71) operations is reviewed in this article, focusing on the evolution of the program through MM'71, into its current status, and planned configuration for Pioneer G and Mariner Venus/Mercury 1973 mission support. The program's current organization structure is adaptive to both mission operation support and management information support environments. Thus concurrent efforts are being expended on the adaptability of the present system to data management systems involved in hierarchical reporting relationships concerned with user–operations–management interfaces.

I. Introduction

The Traceability and Reporting Program (TARP) is a file management scheme based on Informatics MARK IV software, operating in either an IBM 370/155 or 360/75 system environment. Specifically, TARP is utilized to provide data administration, i.e., the accountability of and accessibility to network data records, and the retrieval and reporting of information concerning those records for network management and users. The significant capability of TARP is the linkage developed for coordination of information from multiple network sources (Deep Space Stations, Ground Communications Facility, Monitor, Operations Support) enabling summary profiles for a particular spacecraft, station, and GMT day of year (DOY) combination to be assembled. Linkage is established within the DSN Scheduling System by assigning a "key" to scheduled spacecraft, station, and DOY combinations. Thus, all network system records, hard copy, and magnetic data generated during a tracking sequence are commonly addressed under a key assigned to that particular sequence (Fig. 1).

There are four methods used in TARP to enable a requestor to narrow the search for a desired item. They are used sequentially, in order of selectivity and efficiency of search. The first method provides an efficient way to initially narrow the search, while in the last, a much higher selectivity of the remaining items is provided. The methods are:

(1) Hierarchical classification—basic subject category breakdown

(2) Semantical characterization—subject distinction/qualification

(3) Free-form search—specific word or phrase search

(4) Data content examination—selected item reduction and analysis

II. Mariner Performance Review

Management of information implies the understanding of the requirements acquired data must serve or meet. Of the different types of data acquired and recorded by the DSN during the Mariner Mars 1971 (MM'71) mission, engineering data concerning the functions of the spacecraft and performance data concerning the functions of the DSN operations were basic to TARP. Engineering data were used for System Data Record (SDR) and subsequent Master Data Record (MDR) production as deliverable products to the Project for Experimenter Data Record generation. The utility of DSN performance data was directed toward the effective management of the DSN itself.

A Management Information System (MIS) such as TARP, unlike most information systems designed to perform specific functions, has greater utility and potential when utilizing input information from a broad base to produce reports that enable accurate and expeditious user analysis/judgment.

TARP operates in a nonreal-time mode; data are transferred into ODC from real-time systems either by card input or manual abstraction of information from source hard-copy and/or network monitor summaries (Ref. 1). This information interface resulted in the development of forms to expedite the transfer of information, as well as to minimize the translation of information from one form to another for keypunching functions. It became obvious that in order to secure the needed inputs reliably, the information had to be accepted by the system in the form that was most useful to the source activity (Network Monitor) responsible for its submission. Resultant forms had system compatible formats requiring the entry of specific information into predefined areas from which keypunching or abstration could take place without any additional or transitional forms being required. This process enabled efficient and expeditious entry of information into TARP. In addition, it introduced a sense of discipline regarding the recording and reporting of information in such a way as to facilitate retrieval and search strategies to meet user requests.

As previously reported (Refs. 2 and 3), information system design is based on two "knowns": (1) the type of data or information generated or put into the system and (2) end user requirements—specifically, quantity, quality, format, form, and frequency of information. Throughout MM'71, the type of data entering the system remained constant; however, user request characteristics and patterns for information requests changed frequently. It was found that once data entered TARP in specific order and coding, concomitant with the frequency of change in request patterns, the program was somewhat inflexible in meeting those requests. By pursuing trade-off analysis of physical vs. logical data structure, a solution for data definition (preparation and entry) was derived. It consisted of reducing the detailed coding or indexing of specific information units, and creating "classes" of information in which specific units could be entered as well as retrieved either by unit or collectively with no loss in time.

Figure 2 represents a page generated by TARP for the DSN Monthly Operations Report showing classes of data from individual systems. In the generation of the Monthly Operations Report, the TARP process replaced a lengthy manual collection and documentation function, allowing earlier publication of the document by a minimum of 3 weeks. Additionally, owing to its flexibility, the document format has become a standard user reference, and a base for further report generation.

The information concerning magnetic tape data records, including original, system and master data records—a significant portion of the operations information—was segregated into a sub-function of TARP in terms of method for input and record structure. This information was entered into the Traceability and Accountability (TRACC) subfile. As a subfunction, TRACC is a necessary transaction-oriented step in the DSN/project data transfer and logistics activities (Fig. 3). The occurrence which necessitated the incorporation of TRACC was the requirement to lengthen Original Data Record retention cycles and to retain SDRs until MDRs were transferred to and accepted by project. Subsequent to MM'71, the SDR/MDR production was transferred from the DSN to the Mission Control and Computing Center; future DSN emphasis, in terms of TRACC, will be oriented toward the accountability of system and Network Performance Records, along with various Ground Communications Facility and Deep Space Station log tapes.

III. Evolution and Development

The characteristics of Network Performance information requirements place limiters on the scope or latitude of possible systems design. These characteristics differ with respect to (1) the type of information storage medium to be utilized, (2) the complexity of retrieval algorithms that can be employed efficiently, and (3) the types of functional activities necessary on the part of the information analyst to effect retrieval of information. Thus, to maximize the efficiency of an existing system within a new environment (structured by data processing, hardware and software innovations, and new user requirements), the information processing flow must be segmented into its three principal modules and evaluated as to their respective individual capabilities and possibilities.

The three basic information processing modules are (1) data definition (entry and coding) and abstraction, (2) processing, and (3) selective dissemination of information. Of the three modules, only the first offers individual flexibility, yet it determines overall system performance. From this point of reasoning, TARP development has emphasized data definition and entry in software and hardware consideration. Subsequent to MM'71, TARP has been operating exclusively on the 370/155 system, allowing execution from an IBM 2780 remote job entry (RJE) terminal and offering on-line system access for data entry, deletions, reorganization controls, and report generation. In the near future, the 370 system will be upgraded to a level which allows for "virtual storage" and provisions for multiple RJE terminal access for on-line operations.

Internally, within the Network Operations Program Support element, it is hoped that a closer interface of nonreal-time software files will establish a paradigm for commonality, in terms of accessibility via a linkage concept somewhat like that within TARP. The development of such a paradigm would enhance the completeness and responsiveness of a Network Operations Information Process.

IV. Conclusion

Mariner Mars 1971 TARP operations have successfully identified areas of information acquisition and dissemination not heretofore considered. Those concepts developed during the course of MM'71 provide a basis for further development and planning toward a common network data base indifferent to software consideration, yet addressed to user requirements and satisfaction.

References

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2. Miccio, J. A., "DSN Traceability and Reporting Program: Micrographic Application," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VII, pp. 185–187, Jet Propulsion Laboratory, Pasadena, Calif., Feb. 15, 1972.
3. Miccio, J. A., "DSN Traceability and Reporting Program," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. II, pp. 145–147, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1971.

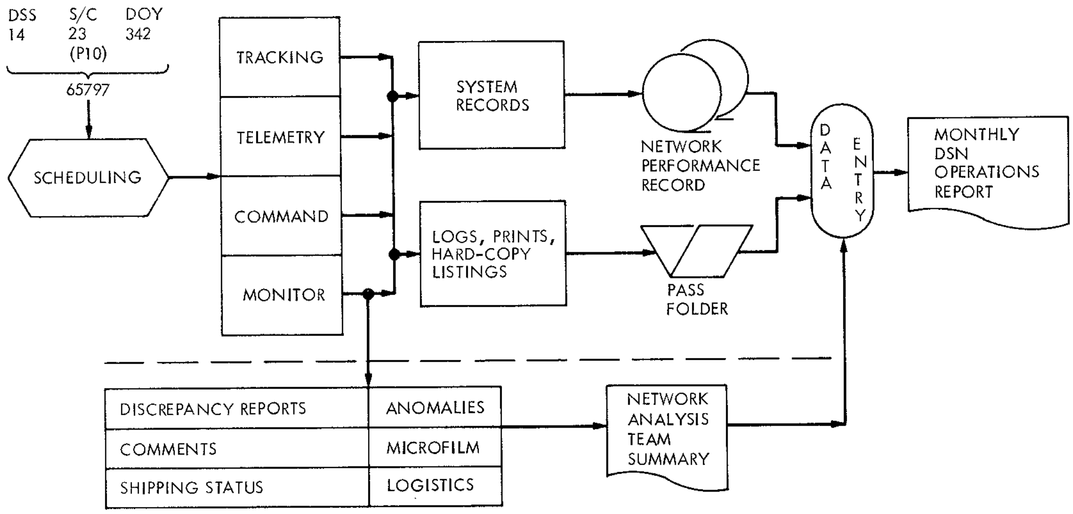

Fig. 1. Mission key assignment providing linkage association to network data records

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                    OPERATION DATA CONTROL

                 MONTHLY REPORT FOR JUNE 1972

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PASS  GMT-START    GMT-END      DATA
NO.                             DAY
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MM9CFZ65797

0387  721711506    721720416    0387
          DSS 14 PASS 387  CL F-8 CTDN 343254 GCF S40D CPS N/A  DSS D000
          CONFIG    ----------------------------------------------------
                    ACS DOY 171  LOS DOY 172          TOTAL
                    SCHEDULED 1507Z SCHEDULED 0416Z SCHEDULED 13H 09M
                    ACTUAL    1506Z ACTUAL    0416Z ACTUAL    13H 10M
                    ST XFR    N/A Z RELEASE   0430Z DSS TIME  13H 24M
          COMMAND   ----------------------------------------------------
                    TOTAL  0   AUTO  0   MANUAL  0   ABORT  0
          TELEMETRY*----------------------------------------------------
                    POWER N/AKW  BIT RATES   8 1/3     33 1/3
                        RX I   RX 1  TCP A ENG TCP A ENG
                    ACTUAL 164.7  149.8   8.0       6.9
                    PREDIC 164.1  149.6   6.0       6.7
                    RESID   -0.6   -0.2  +2.0      +0.2
          TRACKING  ----------------------------------------------------
                    TRACK MD  3 WAY RANGING NONEBIAS N/A RU NOISE N/A RU
                    DCP BIAS  -191  HZ C NOS  .010HZ EXP  .010HZ
          MONITOR   ----------------------------------------------------
                       LGWR  LGER  BLRC  BLER
                    DIS  2165    2     0     0
                    TCPB 3697    2    18     0

          COMMENTS  ----------------------------------------------------
          BIT RATE      4.05       8.1
                    TCP B SCI TCP B SCI
          ACTUAL        5.3        3.2
          PREDICT       4.9        3.1
          DIFFER       +0.4       +0.1
          1749Z-1752Z 360 DOWN TO LOAD VERSION 12.4 (SCHEDULED)
          2001Z-2054Z LOST ALL COMM CKTS EXCEPT WIDEBAND DATA LINE,
          ELECTRICAL FIRE AT DSS-14. DR 5703.
          2230Z-2233Z LOST HSD. DR 5707.
          0228Z-0247Z 360 DOWN - TOTAL LOCKOUT, FORCED R DUMP IPL/WARM
          AND RESTART/WARM. DR 3696.
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Fig. 2. Individual network "data class," assembly by mission key, from DSN Monthly Operations Report

OPERATIONAL DATA CONTROL
PIONEER MAGNETIC TAPE REPORT
BY
GMT START TIME

DATA DAY	PASS NO.	GMT-START	GMT-END	DOCUMENT NO.	MSN KEY NO.	CONFIGURATION
NT-DSN NETWCRK ANALYSIS TEAM						
					TELEMETRY	
		721921315	721922359	MDR 8499	P10CGY00051 REF MDR 8499	TEL COMPOSITE
		721942359	721952359	SDR 8925	P10CGY08925 D-8973 TO OCIS 8-17-72.	TEL COMPOSITE
		721960000	721962359	SDR 8934	P10CGY08934 D-8965 TO OCIS 8-16-72.	TEL COMPOSITE
		721970000	721972359	MDR 8716	P10CGY08716 XFER TO ARC 7-24-72.	TEL COMPOSITE
		721980000	721990000	SDR 5860	P10CGY05860 D-5070 TO OCIS 8-10-72.	TEL COMPOSITE
		721990000	721992359	MDR 8431	P10CGY00052 XFER TO ARC 8-3-72. VAL CGMY	TEL COMPOSITE
		722000000	722010000	SDR 6107	P10CGY06107 D-6072 TO OCIS 8-14-72.	TEL COMPOSITE
		722020000	722022212	MDR 8755	P10CGY08755 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722022212	722022359	MDR 8736	P10CGY08736 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722030000	722031951	MDR 8740	P10CGY08740 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722031951	722032359	MDR 8741	P10CGY08741 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722040000	722041921	SDR 5210	P10CGY05210 D-8642 TO OCIS 8-10-72.	TEL COMPOSITE
		722040000	722042009	MDR 8753	P10CGY08753 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722041921	722042359	SDR 6147	P10CGY06147 D-8641 TO OCIS 8-10-72.	TEL COMPOSITE
		722042009	722042359	MDR 8754	P10CGY08754 XFER TO ARC 8-1-72. CGMY	TEL COMPOSITE
		722050000	722051303	SDR 4095	P10CGY04095 D-8590 TO OCIS 8-15-72.	TEL COMPOSITE
		722051303	722052359	SDR 4287	P10CGY04287 D-6201 TO OCIS 8-15-72.	TEL COMPOSITE
		722060000	722062359	SDR 4399	P10CGY04399 D-5105 TO OCIS 8-17-22.	TEL COMPOSITE
		722060000	722062359	SDR 4403	P10CGY04403 D-4871 TO OCIS 8-8-72.	TEL COMPOSITE
		722070000	722072310	SDR 5868	P10CGY05868 D-8971 TO OCIS 8-17-72.	TEL COMPOSITE
		722072310	722072359	SDR 8951	P10CGY08951 D-8972 TO OCIS 8-17-72.	TEL COMPOSITE
		722080000	722082359	SDR 5227	P10CGY05227 D-5254 TO OCIS 8-8-72.	TEL COMPOSITE
		722090000	722092359	SDR 5173	P10CGY05173 D-6251 TO OCIS 8-1-72.	TEL COMPOSITE

Fig. 3. TRACC format in chronological sequence by spacecraft, identifying data record transfer activity